Zootaxa 633: 1–12 (2004)
www.mapress.com/zootaxa/

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

633

A checklist of polyclad flatworms (Platyhelminthes: Polycladida) from the Caribbean coast of Colombia, South America

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Abstract

Although the Polycladida (Platyhelminthes) are prominent members of many reef communities, no comprehensive surveys exist for the Caribbean coast of Colombia. This study represents a first survey of the Colombian polyclad fauna. A total of 25 species were collected from the rocky littoral of the Tayrona National Park, Santa Marta, Colombia. Because color and color patterns represent major taxonomic characters in the classification of polyclads, photographic records were obtained from live specimens prior to fixation. Further taxonomic identification was based on major external features and serial longitudinal sections of the reproductive system. Numerically, *Boninia divae* Marcus and Marcus, 1968, followed by *Styloplanocera fasciata* (Schmarda, 1859) were the most abundant species. Not only do all recorded species constitute first records for the Colombian coast of the Caribbean, but *Cestoplana rubrocincta* (Grube, 1840), *Armatoplana divae* (Marcus, 1947), *Phaenoplana longipenis* (Hyman, 1953), *Eurylepta aurantiaca* Heath and McGregor, 1912, *Thysanozoon* cf. *lagidum* Marcus, 1949, and *Prosthiostomum gilvum* Marcus, 1950 represent first records for the entire Caribbean region. Furthermore, a new combination *Phrikoceros mopsus* nov. comb. is proposed, and a possible new species of *Pleioplana* Faubel, 1983 was found.

Resumen

Aunque los Polycladida (Platyhelminthes) son miembros prominentes de muchas comunidades arrecifales, no existe ningún estudio para la costa del Caribe Colombiano, convirtiéndose este en el primero para la fauna de polycladidos de Colombia. Un total de 25 especies fueron encontradas en el litoral rocoso del Parque Nacional Natural Tayrona, Santa Marta, Colombia. Registros fotográficos fueron obtenidos de los especímenes vivos antes de ser fijados debido a que el color y patrón de coloración representan el pricipal caracter en la clasificación de los polycladidos. Además la identificación taxonómica fue basada en las principales características externas y secciones longitudinales seriadas del sistema reproductivo. Numéricamente, *Boninia divae* Marcus and Marcus, 1968, seguido por *Styloplanocera fasciata* (Schmarda, 1859) fueron las especies más abundantes. No solo todos los registros son los primeros para la costa Caribe Colombiana sino que *Cestoplana rubrocincta* (Grube, 1840), *Armatoplana divae* (Marcus, 1947), *Phaenoplana longipenis* (Hyman,

Accepted by W. Sterrer: 9 Aug, 2004; published: 8 Sept. 2004

1953), *Eurylepta aurantiaca* Heath and McGregor, 1912, *Thysanozoon* cf. *lagidum* Marcus, 1949 y *Prosthiostomum gilvum* Marcus, 1950 representan primeros registros para la región Caribe en su totalidad. Adicionalmente, una nueva combinación *Phrikoceros mopsus* nov. comb. es propuesta y una posible nueva especie de *Pleioplana* Faubel, 1983 fue encontrada.

Key words Polycladida, Acotylea, Cotylea, turbellarians, Caribbean biodiversity

Introduction

Members of the flatworm order Polycladida commonly dwell on coral and rocky reefs, and may live in association with other invertebrates, especially mollusks, crustaceans and echinoderms. The main characteristic of the group is a highly branched intestine (Hyman 1951), from which they derive their name. Polyclads have few external taxonomic characteristics and positive species identifications are mostly based on the structure of the reproductive system. The initial division of the order into two suborders, namely the Acotylea and the Cotylea, is based on the absence or presence of a ventral sucker, respectively (Lang 1884). Additional external characteristics used for taxonomic identifications include the presence and arrangement of eye spots (e. g., cerebral, tentacular, clustered, marginal), the presence of either true tentacles or pseudotentacles (i. e., mere folds of the anterior body margin), and the structure of the pharynx (Newman & Cannon 1994b). Among the Cotylea, many species are conspicuously colored and exhibit striking color patterns. Hyman (1954) and Prudhoe (1985, 1989) both maintained that cotylean color patterns represent valid systematic characteristics that can be used for taxonomic identifications. Newman and Cannon (1995a) also have demonstrated the importance of color and color patterns in the identification of cotyleans. However, in most cases, and especially for acotyleans, unequivocal species identifications are based on serial sections of the reproductive system (Faubel 1983, 1984).

The greatest number and diversity of genera and species occur in tropical regions (Prudhoe 1985). But despite numerous species of tropical polyclads recorded (Hyman 1954, 1955a, b, 1959a, b; Marcus 1960; Marcus & Marcus 1968; Prudhoe 1985; Jennings & Newman 1996a, b; Newman & Cannon 1994a, b, 1996a, b, 1997, 1998, 2000, 2002; Newman et al. 2003), their diversity is not well known because of difficulties in collecting, handling, and identifying specimens. Many of the earlier studies based their descriptions on single specimens that, in some cases, were immature, or on preserved specimens that were badly contorted due to improper fixation. Because of their extremely fragile nature and tendency to autolyse, polyclads are rarely collected intact and, as a consequence, they are inadequately represented in museum collections. Finally, any diagnostic color or color patterns fade and disappear rapidly after fixation, and thus, there is a great need for photographic documentation of living specimens, an approach initiated only recently with the work of Newman and Cannon (1994a, b, 1995a).

Currently, two polyclad classification systems exist (Faubel 1983, 1984; Prudhoe 1985). The classification system of Faubel (1983, 1984) is based on the characteristics of the male reproductive system, specifically the structure of the prostatic vesicle and its orientation and relationship to the ejaculatory duct. The present checklist mostly follows the classification system proposed by Faubel (1983, 1984) with the inclusion of the new genus *Phrikoceros* that had been proposed by Newman and Cannon (1996a). Knowledge about Caribbean polyclads is limited to the works of Hyman (1955a, b), Prudhoe (1944), and Marcus and Marcus (1968), and is non-existent for the Caribbean coast of Colombia. This study represents the first such survey of Colombian polyclads, and therefore all specimens are first records for this area.

Collection sites and methods

Three collection sites (240 m^2 combined area), Punta de Betín, Playa Cristal, and Inca-Inca Bay were selected based on habitat features and accessibility. Punta de Betín (74° 13' W; 11° 15' N) is located in the northeast of Santa Marta Bay, forming a rocky peninsula that consists of small hills covered with xerophytic vegetation. The peninsula is composed of metamorphic rock, forming rocky cliffs. In addition to both flat and inclined sandy bottoms, some coral reef patches are present between 5 m and 25 m depth. Two currents converge at this site. A northern current that provides oceanic waters and a southern current that brings turbid waters with high levels of sediment and nutrients from the Cienaga Grande de Santa Marta (mangrove swamp), Manzanares River and Gaira River.

Playa Cristal (74° 04' W and 11° 19' N) is located in the northeast of Neguange Bay and is part of the Tayrona National Park. It is the biggest bay within the park. Its western side is formed by rocky littoral with a small sandy beach. The area receives a freshwater input from the Quebrada Rodriguez River (Little River). Three different types of habitats are found in this area: coral reefs, mangroves and seagrass beds.

Inca-Inca (74° 14' W; 11° 11' N) is located in Gaira Bay, 6 km southeast from Santa Marta. The bay is shallow and has a short shelf that helps bring up deep water during times of upwelling. The circulation of the currents in this region depends on the circulation of the wind. During the dry period (December through April), a continuous and strong wind from the northeast (Alisios) produces an east-west current running parallel to the coastline. During the rainy period (August through November), a countercurrent running west to east is generated. During that time, a strong wind from the south and southwest (Vendavales) may be present and together with freshwater from the Magdalena River and effluents of the Santa Marta mangrove swamp produce nutrient enriched waters.

To assess abundances, the sampling regime included two 10 x 4 meter quadrants at Inca-Inca and Playa Cristal, and one 10 x 4 meter quadrant at Punta de Betín. However, to augment taxonomic information, additional random searches were conducted. Specimens

were collected from under rocks in the littoral zone by gently lifting the animals off the substrate using a small paintbrush. Whole animals were photographed *in vivo* to record color and color pattern. After photography, animals were coaxed onto pieces of filter paper and placed onto a small amount of frozen 10% buffered formalin. Animals were covered completely with additional fixative and smoothed with a paintbrush to assure that they were fixed flat. This method is a modification of the method of Newman and Cannon (1995a). It represents an important improvement over past fixations, which usually had resulted in contorted and broken specimens rendering them useless for taxonomic purposes.

After fixation, morphometric measurements were taken of the worms (e. g., body length and width, ratio of pharynx length to total body length). Paraffin-embedded animals were sectioned sagittally, and the sections were stained with hematoxilin and eosin. Taxonomic identifications were based on Faubel (1983, 1984). All material was deposited in the Museo de Historia Natural Marina de Colombia (MHNMC) at the Instituto de Investigaciones Marinas y Costeras (INVEMAR) in Santa Marta, Colombia (Appendix).

Results and Discussion

A total of 372 specimens (25 species in 12 families) were found in the areas surveyed. In terms of absolute abundances, 70.16% was found at Inca-Inca, 18.28% at Punta de Betín, and 11.56% at Playa Cristal (Neguange). Despite having the lowest numerical abundance, Playa Cristal still had the greatest species richness (8 species), followed by Inca-Inca (7 species) and Punta de Betín (3 species). Overall, the most abundant species were *Boninia divae* (76.09%) followed by *Styloplanocera fasciata* (9.16%), *Melloplana ferruginea* (5.57%), *Pleioplana* sp. (2.42 %), and *Notoplana queruca* (1.88%).

All 25 species found in the rocky littoral of the Santa Marta region represented new records for the Colombian Caribbean. Twenty specimens were identified to species and two *(Notocomplana* sp., *Pleioplana* sp.) were identified to genus (Appendix). An additional specimen was identified to family (Prosthiostomidae), and two specimens have been assigned to the suborder Acotylea. A potentially new species *(Pleioplana* sp.) was found (Appendix) and will be the focus of a separate paper (Bolaños et al. in prep). Color and color pattern have been recorded photographically for all but one species (Plates: pp. 6–7).

In his classification system, Faubel (1983) revised the genus *Notoplana* (Notoplanidae) by establishing six new genera *(Chiliplana, Notocomplana, Notoplehnia, Tripyloplana, Pleioplana, Melloplana)* and separating *Melloplana* and *Pleioplana* into a newly established Pleioplanidae. He defines the family based on a prostatic vesicle that is completely filled with well-defined, tubular chambers. Species within *Melloplana* are characterized by a papillate penis, whereas those in *Pleioplana* have armed penes (Faubel 1983). With respect to the Pleioplanidae, we concur with Faubel's (1983) new genera and thus, list *Melloplana ferruginea* in our checklist (Appendix).

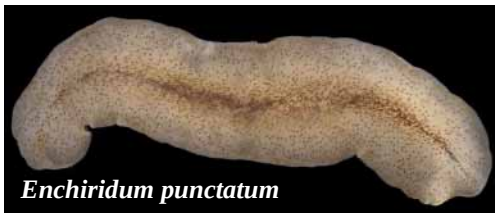
Taxonomic surveys of polyclads in the Caribbean include Prudhoe (1944), Hyman (1955a, b), and Marcus and Marcus (1968). However, most of the descriptions were based on poorly preserved specimens without color documentation, and often the specimens had been collected by other investigators. Because no color documentation exists for these specimens, it is difficult to recognize actual species using the descriptions of these authors.

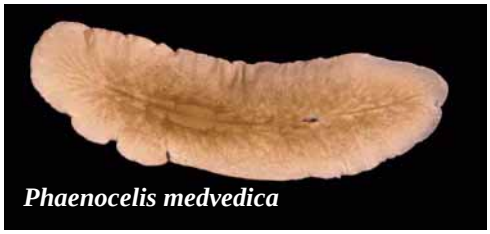
Prudhoe (1944) focused on flatworms collected in the Cayman Islands. He described three species of Acotylea and one species of Cotylea. Additional records on 14 acotyleans and 10 cotyleans from the Caribbean were reported by Hyman (1955a, b). These specimens were from the US Virgin Islands, Jamaica, Puerto Rico, Bermuda, the Bahamas, Dominica, and Florida. Most of the specimens were collected by other investigators and were poorly preserved. Again, no color or color patterns were recorded. Marcus and Marcus (1968) described 28 acotyleans and 21 cotyleans from the Lesser Antilles, Puerto Rico, Key Biscayne, and Brazil. Accounting for any overlap among these surveys, a total of 40 acotyleans and 28 cotyleans have been recorded for the Caribbean. Comparing our findings to these previous studies, we find that *Cestoplana rubrocincta*, *Armatoplana divae*, *Phaenoplana longipenis*, *Eurylepta aurantiaca*, *Thysanozoon* cf. *lagidum*, and *Prosthiostomum gilvum* represent first records for the entire Caribbean region.

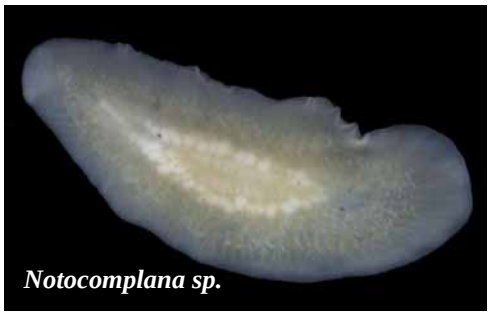
In addition, a new combination *(Phrikoceros mopsus* nov. comb.) was recorded. *Phrikoceros mopsus* (Marcus, 1952) had been described previously as *Pseudoceros mopsus* Marcus, 1952. Like *Pseudoceros*, members of *Phrikoceros* have a single male reproductive apparatus, but they are distinguished from that genus by deep marginal ruffling, simple pharyngeal folds and the arrangement of clustered, dorsal and ventral pseudotentacular eyes (Newman & Cannon 1996a). Using these characteristics, the specimens collected in this study clearly belong to the genus *Phrikoceros*, which led us to the establishment of *Phrikoceros mopsus* nov. comb.

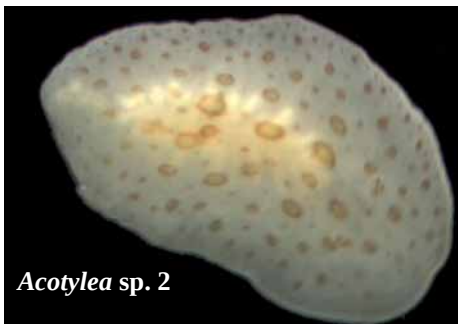
Our findings suggest that the Caribbean is indeed a region of high polyclad diversity, although to date it remains understudied as demonstrated by our new regional records. New methods of fixation (Newman & Cannon 1995a) and the addition of photographic records are important and necessary improvements to the study of these animals. Understanding polyclad diversity has implications for many other fields of biology. For example, acotyleans are major predators of sessile marine invertebrates, including commercial bivalves (Pearse & Wharton 1938, Newman et al. 1993, Jennings & Newman 1996a, b). Cotyleans are of importance in the study of aposematic coloration in marine invertebrates (Ang & Newman 1998). Finally, polyclads are of increasing interest in the search for new drugs from the sea (Carté 1996), in fact, it has been shown that some species contain chemicals that can kill human cancer cells (Kubanek et al. 1995). Progress in all these fields, though, hinges on a thorough understanding of polyclad systematics, including their distributions and abundances.

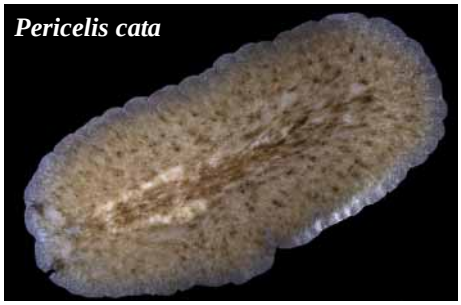
PLATES: Photographic Records of Colombian Polyclads (pages 6 and 7).

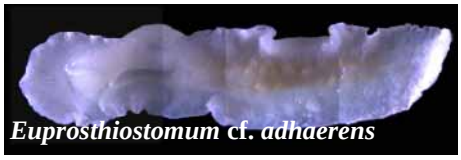












Acknowledgements

We thank Dr. L. J. Newman for help with the identifications and Mr. N. E. Ardila for his contributions and advice. This work was supported through INVEMAR, and in part, through the Agricultural Experiment Station of the University of New Hampshire. This is scientific contribution No. 2246 of the New Hampshire Agricultural Experiment Station.

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Appendix. Polyclads of the Colombian Caribbean

Voucher: vouchers were photographed and deposited at the Instituto de Investigaciones Marinas y Costeras (INVEMAR) in Santa Marta, Colombia as whole mounts; additionally when indicated also as histological sections (HS).
Locality: 1: Punta de Betín; 2: Playa Cristal; 3: Inca Inca
Synonyms: see list at end of appendix.

Taxon	**Voucher**	Reference	Locality	Synonyms
ACOTYLEA: DISCOCELIDAE				
Adenoplana obovata (Schmarda, 1859)	INV PLA001 INV PLA002 HS	Marcus 1950	3	(a)
ACOTYLEA: CESTOPLANIDAE				(b)
Cestoplana rubrocincta (Grube, 1840)	INV PLA003	Haswell 1907	3	
ACOETYLEA: STYLOCHOP-LANIDAE				
Armatoplana divae (Marcus, 1947)	INV PLA004	Marcus 1947	3	(c)
Phaenoplana longipenis (Hyman, 1953)	INV PLA007	Hyman 1953	2	(d)
ACOTYLEA: CRYPTOCELIDAE				
Phaenocelis medvedica Marcus, 1952	INV PLA008 INV PLA009 HS	Marcus 1952	2	
ACOTYLEA: NOTOPLANIDAE				
Notoplana queruca Marcus and Marcus, 1968	INV PLA0010 INV PLA0011 HS	Marcus & Marcus 1968	2	
Notocomplana sp.	INV PLA0012 INV PLA0013 HS	Faubel 1983	2	
ACOTYLEA: PLEIOPLANIDAE				
Melloplana ferruginea (Schmarda, 1859)	INV PLA0014 INV PLA0015 INV PLA0016 INV PLA0018 HS	Hyman 1939a, b, Hyman 1955 a, b, Marcus & Marcus 1968	1, 2, 3	(e)
Pleioplana sp.	INV PLA0019 INV PLA0020 HS	Faubel 1983	3	
ACOTYLEA: GNESIOCERIDAE				
Gnesioceros sargassicola (Mertens, 1833)	INV PLA0021 HS	Hyman 1939b, Marcus & Marcus 1968	3	(f)
Styloplanocera fasciata (Schmarda, 1859)	INV PLA0022 INV PLA0023 INV PLA0024 INV PLA0025 HS	Hyman 1955b, Marcus & Marcus 1968	1, 2, 3	(g)
ACOTYLEA:				
Acotylea sp. 1	INV PLA0049	Faubel 1983	3	
Acotylea sp. 2	No voucher deposited	Faubel 1983	2	

..... continued on the next page

Appendix continued.

Taxon	**Voucher**	Reference	Locality	Synonyms
COTYLEA: BONINIIDAE				
Boninia divae Marcus and Marcus, 1968	INV PLA0026 INV PLA0027 INV PLA0028 HS	Marcus & Marcus 1968	1, 2, 3	
COTYLEA: PERICELIDAE				
Pericelis cata Marcus and Marcus, 1968	INV PLA0030 INV PLA0031 HS	Marcus & Marcus 1968	1, 2	
COTYLEA: PSEUDOCEROTIDAE				
Pseudoceros bicolor Verrill, 1902	INV PLA0032 INV PLA0033 HS	Marcus & Marcus 1968	1, 3	
Phrikoceros mopsus (Marcus, 1952) n. comb.	INV PLA0034 INV PLA0035 HS	Marcus 1952, Marcus & Marcus 1968	3	(h)
Thysanozoon cf. *lagidium* Marcus, 1949	INV PLA0036 INV PLA0037 HS	Marcus 1949	3	
COTYLEA: EURYLEPTIDAE				
Eurylepta aurantiaca Heath and McGregor, 1912	INV PLA0038	Hyman 1953	2	
COTYLEA: PROSTHIOSTOMIDAE				
Prosthostomidae sp. 1	INV PLA0050	Faubel 1984	3	
Prosthiostomum gilvum Marcus, 1950	INV PLA0039 INV PLA0040 INV PLA0041 INV PLA0042 HS	Marcus 1950	1, 2, 3	
Prosthiostomum utarum Marcus, 1952	INV PLA0048	Marcus 1952, Marcus & Marcus 1968	3	(i)
Enchiridium punctatum Hyman, 1953	INV PLA0043 INV PLA0044 HS	Hyman 1953	3	
Euprosthiostomum cf. *adhaerens* Bock, 1925	INV PLA0045	Marcus & Marcus 1968	2	
Euprosthiostomum matarazzoi (Marcus, 1950)	INV PLA0046 INV PLA0047	Marcus 1950, Marcus & Marcus 1968	3	(j)

Synonyms:

(a) *Adenoplana obovata* (Schmarda, 1859) Stummer Traunfels 1933: *Polycelis obovata* Schmarda, 1859; *Leptoplana obovata* (Schmarda) Diesing 1862

(b) *Cestoplana rubrocincta* (Grube, 1840) Lang 1884: *Orthostomum rubrocinctum* Grube, 1840; *Orthostoma rubrocincta* (Grube) Oersted 1844; *Thyphlolepa rubrocincta* (Grube) Stimpson 1857; *Tricelis fasciatus* Quatrefages, 1845; *Cestoplana filiformis* Laidlaw, 1903; *Cetsoplana australis* Haswell, 1907

(c) *Armatoplana divae* (Marcus, 1947): *Stylochoplana divae* Marcus, 1947

(d) *Phaenoplana longipenis* (Hyman, 1953): *Stylochoplana longipenis* Hyman, 1953

(e) *Melloplana ferruginea* (Schmarda, 1859): *Polycelis ferruginea* Schmarda, 1859; *Leptoplana ferruginea* (Schmarda) Diesing 1862; *Discocelis binoculata* Verrill, 1901; *Notoplana bahamensis* Bock 1913; *Notoplana ferruginea* (Schmarda) Stummer Traunfels 1933; *Notoplana binoculata* (Verrill) Hyman 1939; *Notoplana caribbeana* Hyman, 1939

(f) *Gnesioceros sargassicola* (Mertens, 1833): *Planaria sargassicola* Mertens, 1833; *Stylochus sargassicola* (Mertens) Ehrenberg, 1836; *Planocera sargassicola* (Mertens) Oersted 1844; *Stylochus mertensi* Diesing, 1850; *Gnesioceros mertensi* (Diesing) Diesing 1862; *Stylochus pelagicus* Moseley, 1877; *Stylochoplana sargassicola* (Mertens) Graff 1892; *Pelagoplana sargassicola* (Mertens) Bock, 1913

(g) *Styloplanocera fasciata* (Schmarda, 1859) Stummer Traunfels 1933: *Stylochus fasciatus* Schmarda, 1859; *Styloplanocera papillifera* Bock, 1913; *Stylochoplana fasciata* (Schmarda) Lang 1884
(h) *Phrikoceros mopsus* (Marcus, 1952): *Pseudoceros mopsus* Marcus, 1952
(i) *Prosthiostomum utarum* Marcus, 1952: *Lurymare utarum* (Marcus, 1952) Marcus and Marcus 1968
(j) *Euprosthiostomum matarazzoi* (Marcus, 1950): *Prosthiostomum matarazzoi* Marcus, 1950; *Lurymare matarazzoi* (Marcus) Marcus and Marcus 1968